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Springboard

Data Science Career Track

Capstone Final Report

Alzheimer's, Genetics, and the
Microbiome-Gut-Brain Axis:
How Naturopathic Medicine Affects
Alzheimer's

The Problem

The United States Secretary of the Department of Health has declared for many years that the public health crisis of Alzheimer's is an ongoing federal problem that US citizens face. The gravity of this disease is very serious and can be fatal. Today, "nearly 7 million Americans live with Alzheimer's" [1], and "the cost of care yearly is 360 billion USD" [2]. "10% of adults aged 45 and older report subject cognitive decline" [3], which is the earliest warning sign of Alzheimer's disease. "By 2050, nearly 13 million Americans could be living with Alzheimer's [4], where costs will reach nearly \$1 trillion" [5].

Figure. 1 below is taken from the "2024 Alzheimer's Disease Facts and Figures" report from the Alzheimer's Association® [6].

Projected Number of People Age 65 and Older (Total and by Age) in the U.S. Population with Alzheimer's Dementia, 2020 to 2060

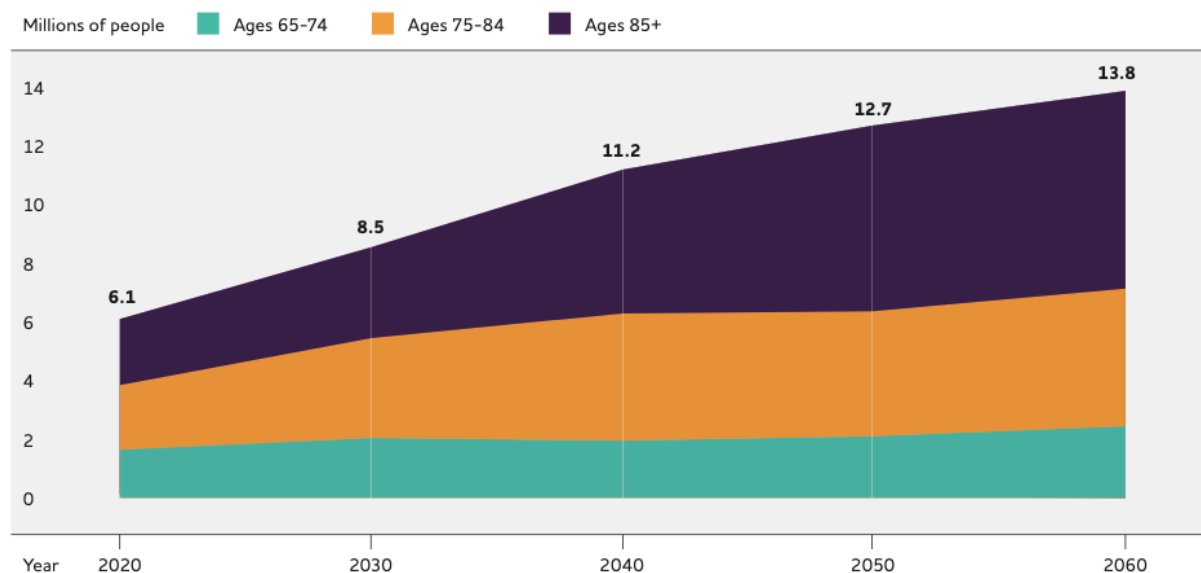


Figure. 1 shows the Alzheimer's Disease projection by year 2060.

What is Naturopathic Medicine?

Conventional medicine is a system designed for a brief consultation with a medical doctor, typically lasting 15 minutes. The goal is to diagnose as quickly as possible and to treat ailments or diseases with prescribed pharmaceuticals. However, this approach often fails to address the root causes of systemic issues affecting a patient's whole body.

Conventional medicine struggles to address the public health crises facing Americans. While it is "highly effective in addressing acute and life-threatening conditions" [7] through surgery and necessary medications, it often falls short as a definitive model for combating public health crises such as Alzheimer's. This limitation contributes to problems such as the opioid crisis and increased rates of ADHD. Although pharmaceuticals are essential in many cases, they are not a comprehensive solution for addressing the functional and holistic health of a patient's entire body, which influences a patient's disease status.

This is where Naturopathic Medicine comes in. This medicine is a science-based paradigm that aims to treat the whole body by identifying and addressing the root causes of disease. It seeks to improve all health markers of a patient's bodily systems through protocols involving nutraceuticals, diet, nutrition, health tests, lifestyle therapies, and natural treatments, allowing a patient's body to heal itself completely or to its fullest extent. Naturopathic Medicine "was founded in the United States in 1901 by Benedict Lust" [8], taken from a movement that was happening at the turn of the century in Europe.

Figure. 2 on the next page depicts the fundamental principles of Naturopathic Medicine.

Our Guiding Principles



Figure. 2 shows the 6 Principles of Naturopathic Medicine [105].

Therapeutic Order and Course of Action in Naturopathic Medicine

1. **First Layer:** *Establish the Foundation for Optimal Health:* A Naturopathic Doctor (ND) educates patients on the basics of living healthy, laying the groundwork for long-term health.
2. **Second Layer:** *Stimulate the Body's Natural Healing Power:* Initially, an ND prescribes supplements or nutraceuticals to address inflammatory or oxidative "bottlenecks." This helps alleviate high levels of inflammation contributing to an ailment [9].
3. **Third Layer:** *Support & Restore the Body's Weakened Systems:* After the baseline education, supplements, and nutraceuticals to handle the major sources of inflammation that contribute to a patient's ailments, protocols and programs of supplements, nutraceuticals, natural therapies, diet, nutrition, and lifestyle changes seek to naturally restore a body's weakened systems completely, or to their fullest possible extent [10]. The following are some biomarker tests that assess the health of bodily systems, along with an example of how they may be weakened. They are labeled from first to last in layers like the pyramid in Figure. 3 as shown below, to also indicate what is more fundamental to overall health.

Bodily Health Systems: Their Sequential Importance and Interconnection

1. **First Layer (Bottom of the Pyramid):** *Gastrointestinal Tract:* A stool test assesses the gut microbiome and intestinal health markers to identify toxic burdens and inflammation from bacteria, pathogens, infections, and overall digestion [11] [12] [13].

2. **Second Layer: *Liver and Detox Tract*:** A hair follicle and mold test assesses heavy metal toxicity and mold levels in a person to evaluate how well a patient is managing oxidative stress and detoxification, which contribute to aging and ailments [\[14\]](#) [\[15\]](#) [\[16\]](#).
3. **Third Layer: *Hormonal System*:** A saliva test that evaluates reproductive hormones' ratios and quantities, which are crucial for inflammation and overall wellbeing. Example: A woman who has chronically low levels of estrogen, which affects her mood and inflammation levels [\[17\]](#) [\[18\]](#) [\[19\]](#).
4. **Fourth Layer: *Adrenal System*:** A day-long saliva test measures cortisol levels throughout the day to assess adrenal fatigue, better known as "burnout" [\[20\]](#) [\[21\]](#) [\[22\]](#).
5. **Fifth Layer: *Neurotransmitter Test*:** A saliva panel evaluates the ratios of neurotransmitters, essential for mental wellbeing [\[23\]](#) [\[24\]](#) [\[25\]](#).
6. **Sixth Layer (Top of the Pyramid): *Genetics Test*:** A saliva test assesses which genes may contain mutations, potentially indicating "dirty genes" needing to be cleaned up. Improvement of the first layer health system improves markers in all subsequent layers. Improving all health system layers before the Genetics Layer consequentially improves the status of the genetics layer [\[26\]](#) [\[27\]](#) [\[28\]](#).

Therapeutic Order and Course of Action in Naturopathic Medicine (continued)

4. **Fourth Layer: *Targeted Natural Prescriptions*:** After weakened bodily systems are completely restored or restored to their fullest possible extent, if there is still a deficiency within the health systems of a patient or other kinds of deficiencies and bottlenecks, then whatever the nutraceuticals from the second layer cannot address is addressed by the addition of targeted natural prescriptions [\[29\]](#).
5. **Fifth Layer: *Replacement Therapy*:** After targeted natural prescriptions are issued, there might still be deficiencies within a patient. For example, testosterone-boosting supplements such as Fadogia Agrestis and Tongkat Ali are potent natural interventions, but a male patient still suffering from low

testosterone will benefit from testosterone replacement therapy [30] [31]. This is a recommended course of action to address this highly inflammatory imbalance.

6. **Sixth Layer: Drug Therapy:** At this stage, if there is still a need to address imbalances within a patient, prescription pharmaceuticals are recommended.
7. **Final Layer: Surgery:** The final stage is invasive surgery to address any structural or biological imbalances that require this level of attention.

Important Note: Since we are a whole body and all of our bodily systems are interconnected as a whole, a heavier inflammatory load in the first layer is a heavier load on all of the following sequential layers. A heavier inflammatory and oxidative load on the fourth layer is a heavier load for the fifth through last layers, etc.

"Conventional medicine typically only addresses replacement therapy, drug therapy, and surgery while ignoring the first four layers of fundamental health."

Figure. 3 in the next page depicts the Therapeutic order of Naturopathic Medicine.

Naturopathic Therapeutic Order

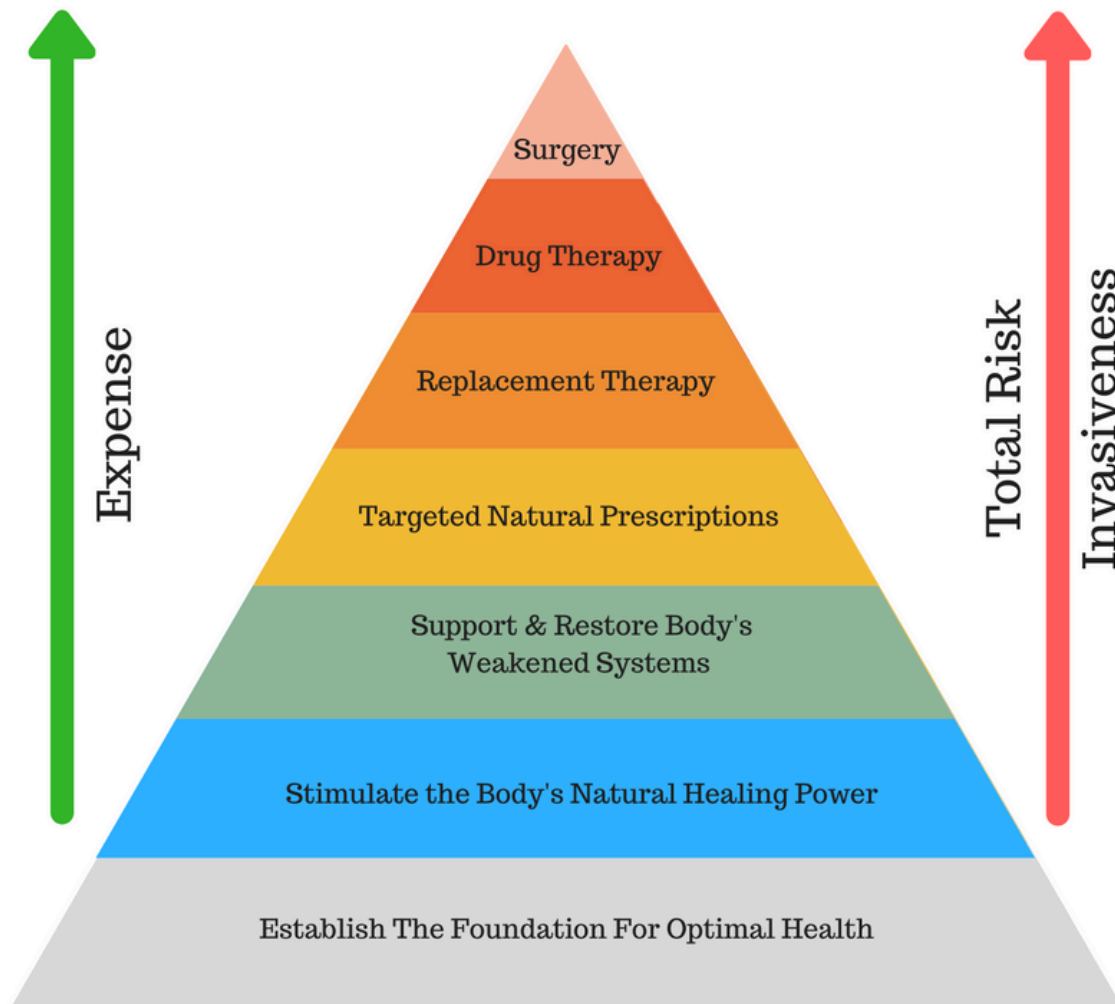


Figure. 3 shows the Seven Layers of Therapeutic Order in Naturopathic Medicine [106].

An Example of a Naturopathic Course of Action

For instance, a Naturopathic Doctor (ND) might order a stool test to assess biomarkers of gastrointestinal health. Based on the results, the ND would prescribe nutraceuticals or herbal supplements as part of a baseline protocol to address imbalances in the patient's GI tract. If a patient has experienced rheumatoid arthritis from a young age, with pain stemming from systemic inflammation caused by all bodily systems, the nutraceuticals, and herbal supplements might help correct imbalances such as low stomach acid (hypochlorhydria) caused by a common bacterial infection in the GI tract, *H. pylori*. The ND might also recommend additional supplements for cleansing and repairing the GI tract to eliminate dysbiosis at later dates [32].

What is Traditional Chinese Medicine?

Traditional Chinese Medicine (TCM) is an ancient practice that spans thousands of years, that has changed little over the centuries. TCM is based on the fundamental concepts of "Yin-Yang" and "Qi". See Figure. 4 below for a depiction of this fundamental concept of TCM. "A vital force of life, called Qi, surges through the body. Any imbalance in Qi can cause disease and illness. This imbalance is most commonly thought to be caused by an alteration in the opposite and complementary forces that make up the Qi... called Yin and Yang" [33].

"The first writings about TCM date back to 200 BCE. Herbal medicine, acupuncture, including theory, practice, diagnosis, and treatment, were recorded in classical Chinese texts and [was] refined over many centuries" [34].

Disease is thought to be alterations in the normal flow of Qi such that Yin and Yang are imbalanced. TCM agrees that an unbalanced Yin and Yang typically has three major causes: external or environmental factors, internal thoughts and emotions, and lifestyle factors. Like Naturopathic Medicine, TCM stimulates the body's own natural restoration and healing processes.

Practices used in TCM include:

1. Herbal medicine
2. Nutrition
3. Acupuncture and acupressure
4. Moxibustion: Burning a herb near the skin
5. Chinese massage: Called Tui Na
6. Exercise: Such as Tai Chi and Qi Gong which combine movement with meditation

TCM like Naturopathic Medicine also believes that our bodily systems are not individual networks, but rather "complex networks" [35]. "According to TCM, Qi flows through organ systems, the kidneys, heart, spleen, liver, lungs, gallbladder, small intestine, and large intestine, by way of meridians"[36] also known as energy pathways.

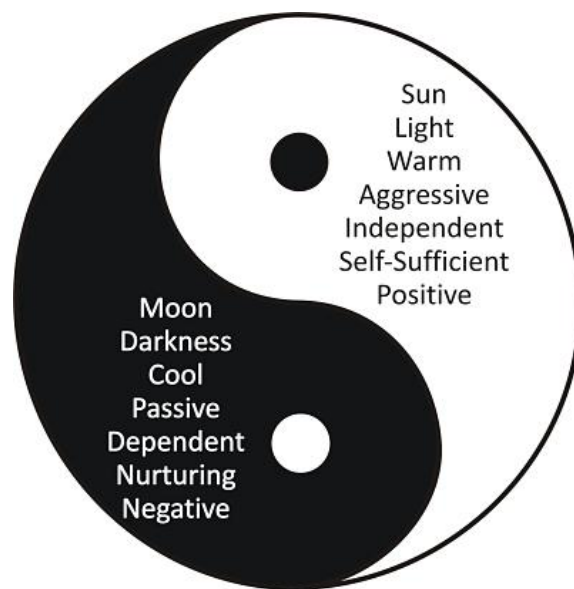


Figure. 4 shows the Fundamental Concept in Traditional Chinese Medicine [107].

Naturopathic Medicine & Traditional Chinese Medicine Compared

"The term "naturopathy" originates from "natura" (Latin root for birth) and "pathos" (the Greek root for suffering) to suggest "natural healing". Naturopaths claim the ancient Greek "Father of Medicine", Hippocrates, as the first advocate of Naturopathic Medicine, before the term existed"[37].

Traditional Chinese Medicine stems from "The Yellow Emperor's Inner Canon (Huangdi Neijing), the oldest received work of Chinese medical theory, [which] was compiled during the Han dynasty around the first century BCE" [38]. "It was also one of the first books in which the cosmological doctrines of Yinyang...were brought to a mature synthesis" [39].

Naturopathic Medicine like Traditional Chinese Medicine where both founded circa 200 BC. Both ancient practices aim to restore a body's natural ability to heal itself through natural purposes because both practices believe that disease is caused by imbalances within the person. Hippocrates who is the "Father of Medicine" postulated that these imbalances primarily stemmed from one's own temperament. The following section aims to describe the vital importance of these temperaments, and how they relate to modern medical theory as a body of my own original work from a lifetime of study. The following paradigm is my life's work which maps temperament and modern medicine together.

Hippocrates' Humoral Theory, Naturopathic Medicine, Modern Medicine, and Archetypes

In medieval and ancient times, all Medical Doctors were instructed in the premise of "Humoral Theory" which was founded by Hippocrates [40]. Humoral Theory states that all people may be categorized by four different types of temperaments, which are marked by excesses in a specific kind of humor [41]. Humor comes from the word human, humor and human from the same root word Humus in Latin which means "earthly". To be human is to have excess or deficiencies of certain humors. "Hippocrates suggested that humors are the vital bodily fluids: blood, phlegm, yellow bile, and black bile [42]. Hippocrates postulated that an extreme excess or deficiency of any of the humors (bodily fluid) in a person can be a sign of illness"[43]. Figure. 5 below shows a German 16th-century drawing of the 4 temperments. Hippocrates lived from 460 – c. 370 BC.



Figure. 5 shows a drawing from the 16th-century of The 4 Temperments in Humoral Theory [108].

The Phlegmatic Temperment



Figure. 6 shows The Phlegmatic Temperment in Humoral Theory [109].

There is much wisdom in making the philosophical claim that excesses and deficiencies, in certain bodily fluids affect your temperament. Take the Phlegmatic temperament. The Phlegmatic is categorized as having an excess bodily fluid of phlegm [44]. Having an excess of phlegm is marked by a later scientific discovery known as "rest and digest" [45]. This is where the parasympathetic system is activated, and all of your bodily energy is focused on resting and digesting food after it is consumed [46]. "Rest and Digest" is opposed to "Fight or Flight" [47] which is marked by feeling a sense of danger or preoccupation where someone feels the need to flee a situation or fight a situation that is usually life-threatening [48]. The "Fight or Flight" state is marked by very

high levels of elevated cortisol [49], the release of adrenaline [50], and catecholamines [51], which is what makes the whole "Fight or Flight" experience a stressful experience.

In "Rest and Digest" the digestive system is activated to break down food, so nutrients may be absorbed [52]. Conditions known as "Burnout" or medically known as "Adrenal Fatigue" are marked by chronically low levels of cortisol, which occurs after someone is constantly pathologically being in a state of "Fight or Flight" [53].

The temperaments go much deeper than just biological processes. Someone who is Phlegmatic, who is constantly in a state of "Rest and Digest", is temperamentally marked as someone who is always calm and never stressed. These are people who are very easygoing. But this goes even deeper still. Because someone is temperamentally "always calm, never stressed, and easy-going", from an Aristotelian-Thomistic perspective on virtues, they can be prone to laziness [54]. Aristotelian-Thomistic virtue ethics states all temperaments have inherent strengths and weaknesses [55].

Someone who is Phlegmatic, who is constantly in a state of "Rest and Digest" is said to have a high concupiscible appetite, which is defined as someone "Who has a great appetite to move towards many pleasurable inherent goods, and move away from arduous evils" [56]. As such, this temperament is naturally very stoic, calm, and peaceful but they may be prone to laziness and be less dutiful from an Aristotelian-Thomistic perspective on virtue ethics that are dispositions in someone's character [57].

The Choleric Temperment



Figure. 7 shows The Choleric Temperment in Humoral Theory [110].

The Phlegmatic temperament is as opposed to the Choleric Temperament, which is marked by a high irascible appetite which is defined as "a great appetite to move towards arduous inherent goods, and away from easy evils" [58]. Hippocrates in Humoral Theory marked the Choleric Temperament as someone who has an excess of the humor "yellow bile" [59]. It was later discovered by modern science that yellow bile is a product that is stored in the gallbladder of a person, that sits just under the liver [60]. Yellow bile is a product of detoxed toxins from stage II detoxification pathways before they are used one more time in the digestive system to help break down fats which are the most calorically dense macronutrient you can eat [61].

The Choleric temperament goes deeper. Since "yellow bile" is the result of detoxed toxins that an individual interfaces with on a daily basis, this temperament is defined as someone who is a "leader", "very hard worker", and "spearhead of work" [62]. Hence, since so much of this temperament aligns with "doing", this temperament

will inevitably absorb more toxins through the skin, and lungs, which inevitably hits our livers to be dealt with in a detoxification process [63].

Someone who is a Choleric, who is constantly working to arduous goods, may be more prone to anger hence the word Choleric which comes from the Latin word for anger "Cholera" [64]. They are typically less tolerant of people and their mistakes from an Aristotelian-Thomistic perspective on virtue ethics within someone's character [65]. They normally deal with more stress than all the other temperaments, so they may be more easily prone to adrenal fatigue or "burnout" [66] [67]. There is much wisdom from Hippocrates' school of thought and his Humoral Theory indeed.

The Melancholic Temperment



Figure. 8 shows The Melancholic Temperment in Humoral Theory [111].

The Melancholic temperament is on a different axis than what the Phlegmatics or Choleric are on. The Phlegmatic is to what is to "be" or "rest", where you do not have to think, feel, or do anything to "be". You just are the summation of everything that you think, feel, or do. Choleric is to "doing", it is an active principle of human nature.

Melancholics are on the thinking and feeling axis, whereas Melancholics are to "reflection", and "discovering and believing the truth for the sake of truth" [68], the final temperament Sanguine is to "feeling" and "feeling interconnected with everything" [69].

Hippocrates stated that Melancholics have an excess of "black bile" which was a liquid that was found in the spleen at the time of Hippocrates [70]. "Black Bile was thought to originate in the spleen, meaning that melancholy... [was]...blamed on the spleen. With an overproduction of Black Bile, a person may have appeared cold and dry, sad in disposition, and overall doubtful of the world" [71]. Modern medicine states that the spleen "stores and filters blood and makes white blood cells that protect you from infection" [72] and "the spleen is part of the lymphatic system" [73]. The lymphatic system deals with the waste that is naturally left behind from natural blood circulation within blood plasma [74].

Since fluid from the spleen is a concentration of white blood cells and lymph, modern medicine affirms that excesses in spleen fluid mark someone who biologically produces more waste in their natural blood circulation [75], hence the reflective nature of this temperament, because "doing" things, and their actions that follow, may lead to greater waste that is produced by their blood exertion in "doing things", which is then picked up by the lymphatic system in blood plasma [76], which connects to the spleen [77].

Someone who is a Melancholic, who is constantly thinking to understand truths, may be more prone to melancholy hence the word Melancholic which comes from the Latin word for sadness "Melancholicus". They typically react more slowly and are affected for a long time from negative events, in an Aristotelian-Thomistic perspective on virtue ethics within someone's character [78]. Aristotelian-Thomistic philosophy states that this stems from this temperament of "never wanting to suffer" [79] hence them falling into a character defect known as fear [80]. Fear is defined as "the feeling that an inevitable evil is coming your way, that you cannot stop" [81] which is why this temperament is by nature also very reflective because they do not want to suffer negative things [82]. This can be offset by growing in the virtues of hope, joy, and gratefulness for one's state in life [83].

Melancholics normally deal with higher levels of serotonin than all the other temperaments, which is an inhibitory neurotransmitter, they are inhibitory towards making rash decisions. Modern Medicine states serotonin and dopamine work in a

push-pull fashion, when one goes lower the other tends to go higher [84]. A Sanguine typically has high constant levels of dopamine, and thus lower levels of serotonin. Dopamine is an excitatory feel-good neurotransmitter for "pursuing goals" [85], and serotonin is the inhibitory feel-good neurotransmitter for "feeling content with what you have" [86]. Melancholics are more easily prone to melancholy or "anxiety" because anxiety is marked by not having enough dopamine to "chase rewards" as a precursor to adrenaline that is released in perceived stressful situations in an anxiety disorder [87]. There is much wisdom from Hippocrates' School of Thought and his Humoral Theory, which still relates to Modern Medicine today.

The Sanguine Temperment



Figure. 9 shows The Sanguine Temperment in Humoral Theory [112].

The final temperament of the four temperaments is the Sanguine Temperament. It is on the same axis as the melancholic temperament. Melancholic is to thinking, as Sanguine is to feeling. The Phlegmatic is to "being", and Choleric is to "doing".

Hippocrates stated that Sanguine's have an excess of the blood fluid [88]. Sanguines are defined as "very charismatic people", they are very social, they want to be connected to everything and they want to feel everything, hence they flow the fluid from the heart [89]. Heart for feeling, blood for passion, and whole body interconnectedness.

Philosophically, the Sanguine differs from the Melancholic in that Sanguines do not have to deal with excess waste within the plasma in their natural blood circulation, which the Melancholic's spleen and lymph have to deal with. The Melancholics have higher rates of waste in their blood circulation by nature, and the Sanguine does not. The Sanguines philosophically deal with less circulating waste in their spleen and plasma, hence why they want to "feel everything" [90] and be "connected to everything in nature" [91], to have a sense of "oneness" [92] that starts in the ventricles of their hearts.

Sanguines are defined from an Aristotelian-Thomistic perspective as "reacting very quickly to negative events, and being undisturbed by them" [93], which is the exact opposite of a Melancholic who "reacts very slowly to negative events, and is affected for a long time by them" [94].

Someone who is a Sanguine who reacts very quickly to negative events, remains undisturbed by them, is very social and very charismatic is from an Aristotelian-Thomistic view "someone who is prone to intemperance" from the dispositions within their character regarding their virtues [95]. Aristotelian-Thomistic philosophy states why this stems from this temperament, it is because by nature they tend to "never want to be apart from pleasure" [96] hence them falling into intemperances such as drug addiction and alcoholism, in which alcoholism is found to have a genetic predisposition within families [97] that are Sanguine. This points to the Modern Medical concept of Epigenetics which states in general that "The summation of all your experiences, good and bad, all influence your genetics, and the genes that are passed down to the next generation up until the very moment of conception of a newborn" [98].

Beyond Just Temperments

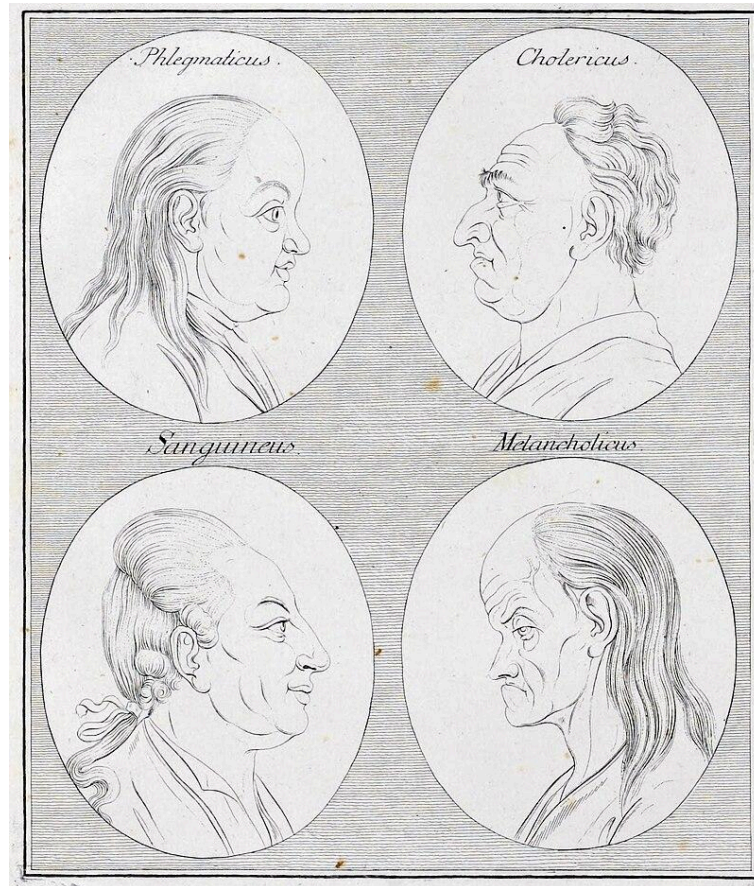


Figure. 10 shows The Faces of the 4 Temperments in Humoral Theory [113].

The paradigm goes much deeper than just temperaments, natural virtue strengths and weaknesses, and biological disease. There is a body of work published by Alexander Lowen who was a student of Wilhelm Reich, a psychologist who was a student of Sigmund Freud, describes in his work that one's temperament and character have "influence in how your anatomy and physiology develops, and in turn, even looks like once adulthood is reached" [99]. That is to say that one's virtues and defects (or character excesses and defects), which symbiotically pair with one's blend of temperments from Hippocrates' Humoral Theory, determine one's own psychology and how one may physically appear in person.

Wilhelm Reich was a direct student of Sigmund Freud [100], Freud pioneered modern Psychology [101]. Reich's "work on character and the idea of muscular armoring contributed to the development of what is now known as... bioenergetic analysis of Reich's student Alexander Lowen" [102] who described formations of human anatomy and physiology as their own kind of "archetype" [103] which is analogous to Hippocrates' Humoral Theory which describes the four temperaments as their own archetypes. Hippocrates's Humoral Theory and Lowen's Bioenergetic Theory are analogous, in that in my own research the temperament archetypes and the "character structure" or "physical appearance" archetypes overlap in their similarities. In other words, each psychological temperament (Humoral Temperament) corresponds to a person's physical appearance in many regards. The body is the mind, and the mind is the body in many respects.

These two sets of archetypes may map to each other, but they are not "hard and fast rules" they are not "completely definitive 100% of the time". It is a metaphysical framework for understanding nature and illnesses. Despite my own life's work in researching and mapping these two paradigms, with the paradigm of modern science, they still describe patterns that can be found within human populations until this day. Patterns are not 100% completely definitive as to what a person's temperament and bioenergetic character structure might actually be, we are usually a blend of two temperaments. These two paradigms only describe archetypes of the human condition, which has been seen since ancient Greek times, and one may postulate that the human condition will not change anytime in the near future. This metaphysical framework still has medical and personal value. Regarding the linking of Hippocrates' Humoral Theory and Lowen's Bioenergetic Analysis, there is much truth to this based on a fundamental concept of biology that states "form follows function" [104] which is from Darwin's Evolution Theory. The nature of nature is all a pseudo-science at its most fundamental concepts, and this is a whole study and discipline that is outside the scope of being further elaborated in this body of work.

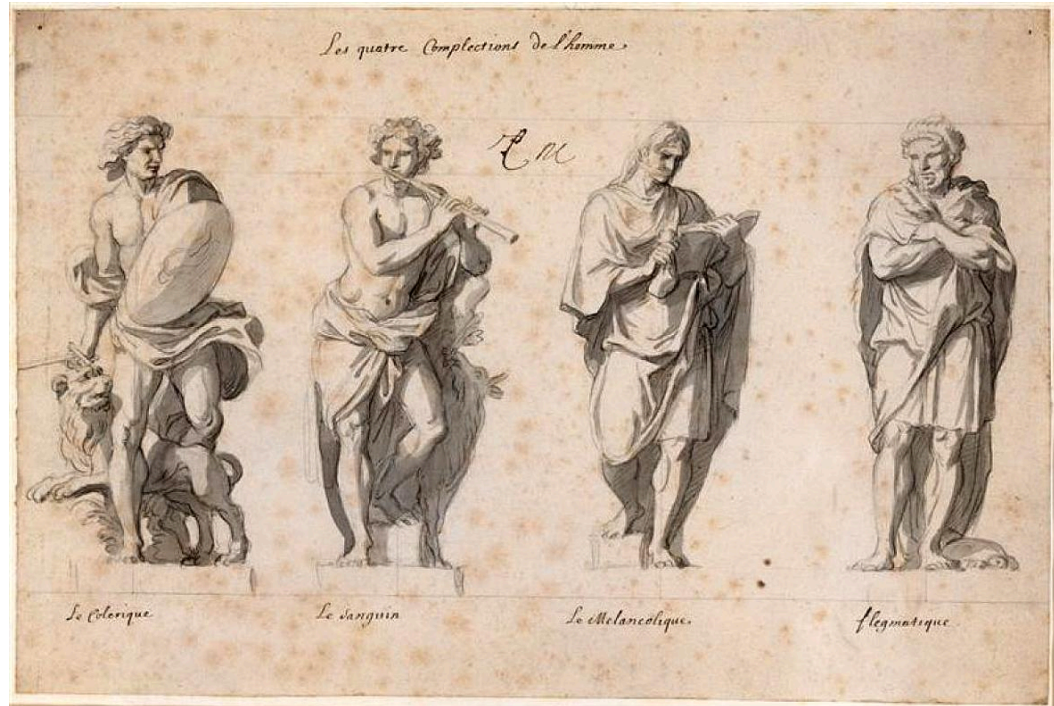


Figure. 11 shows all 4 Temperments in Humoral Theory [114].

The Scope of this Body of Work

The scope of this body of work is limited to the first and final layer (sixth layer) of the "Bodily Health Systems: Their Sequential Importance and Interconnection" section as seen above. This project aims to draw inferences from four datasets which are research studies, that measure biomarkers in genetics, gut microbiota, and biomarkers as seen in the pathology of Alzheimer's disease in the different stages of progression of this pathological phenomenon. Several studies measure the effects of herbal medicine from Naturopathic Medicine and Traditional Chinese Medicine Botany in these two layers of bodily health systems. The purpose of the analysis of this body of work, is to draw inferences from herbal medicine, its effects on gut microbiota, colonic and overall gene expression, and whether or not it has a positive or negative influence on Alzheimer's pathology for research purposes that aim to answer this body of work's project proposal as seen in the section below.

Proposal of Capstone

How does Naturopathic Medicine and Traditional Chinese Medicine herbs, such as Danggui Shaoyao San and Rhodiola Rosea, affect the gut microbiome and thus colonic and overall gene expression, to reduce or prevent the progression of Alzheimer's disease and its pathologies?

Predictions

I predict that the medicinal herbs such as Rhodiola Rosea and Dangui Shaoyao San will positively affect the biomarkers that pertain to its respective gut microbiomes, and will positively affect colonic and overall gene expression, thus reducing and preventing the progression of Alzheimer's disease and its pathologies.

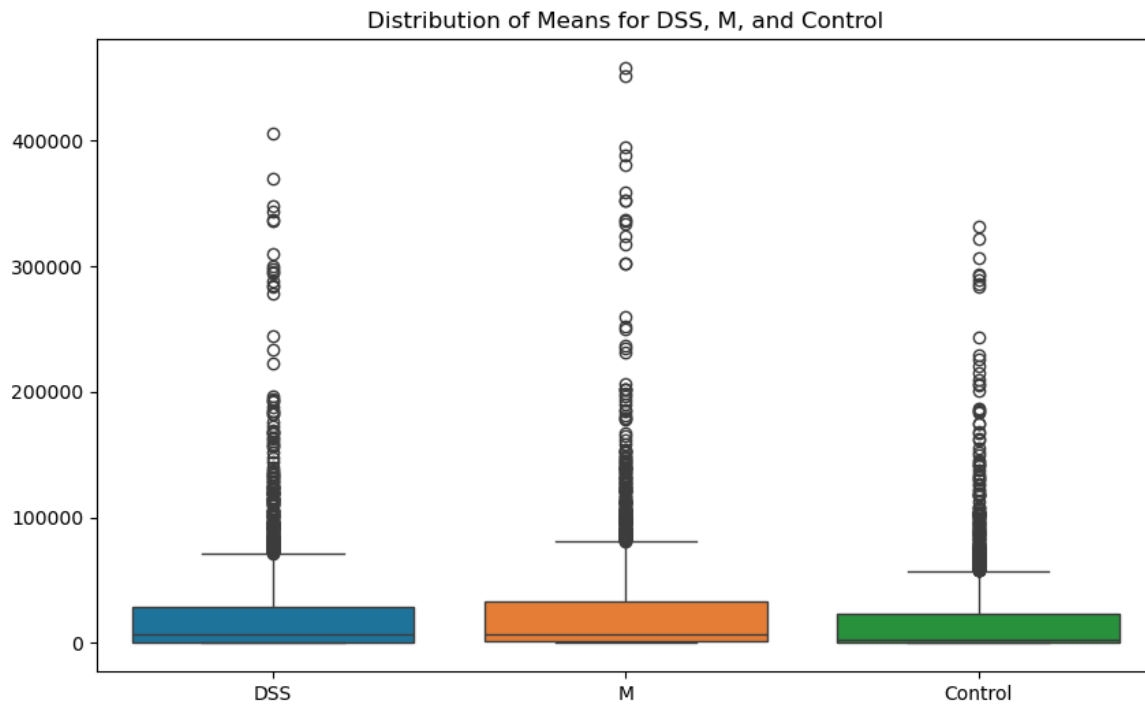
Outcomes

Dataset 1: Dangui Shaoyao San

All of the oxidative stress biomarker averages, and std deviations for the DSS test group are lower than the M group that did not receive DSS even tho both groups are induced with Alzheimer's...interesting. This suggests that DSS reduces and prevents Alzheimer's pathology.

	mean_DSS	std_DSS	mean_M	std_M
1	3826.833333	4733.886457	5489.978	8955.680670
2	5796.226667	5804.802297	8678.71	8993.934839

In inferential statistics, the null hypothesis is rejected that there is no difference in the DSS group, the M group, and Control group's biomarker data. The DSS group has markedly different biomarker measurements than the other two groups. Lower averages than the M group but higher averages than the control group.



In machine learning, the DSS group shows the second highest correlation between its oxidatvie stress biomarkers and the rest of its data, first being the control group. Suggesting that there is a strong correlation that Dangui Shaoyao San driving lower levels of Alzheimer's disease pathology.

```

DSS_6          0.001097
DSS_5          0.018316
DSS_4          0.010785
DSS_3          0.024183
DSS_2          0.010662
...
Con_3          0.011731
Con_2          0.019761
Con_1          0.024481
inflammation_biomarkers NaN
oxidative_stress_biomarkers 1.000000
Name: oxidative_stress_biomarkers, Length: 17, dtype: float64

```

Average for DSS group: 0.0106 Average for M group: 0.0063 Average for CON group: 0.0177 The group with the lowest average is the M group, with an average value of 0.0063.

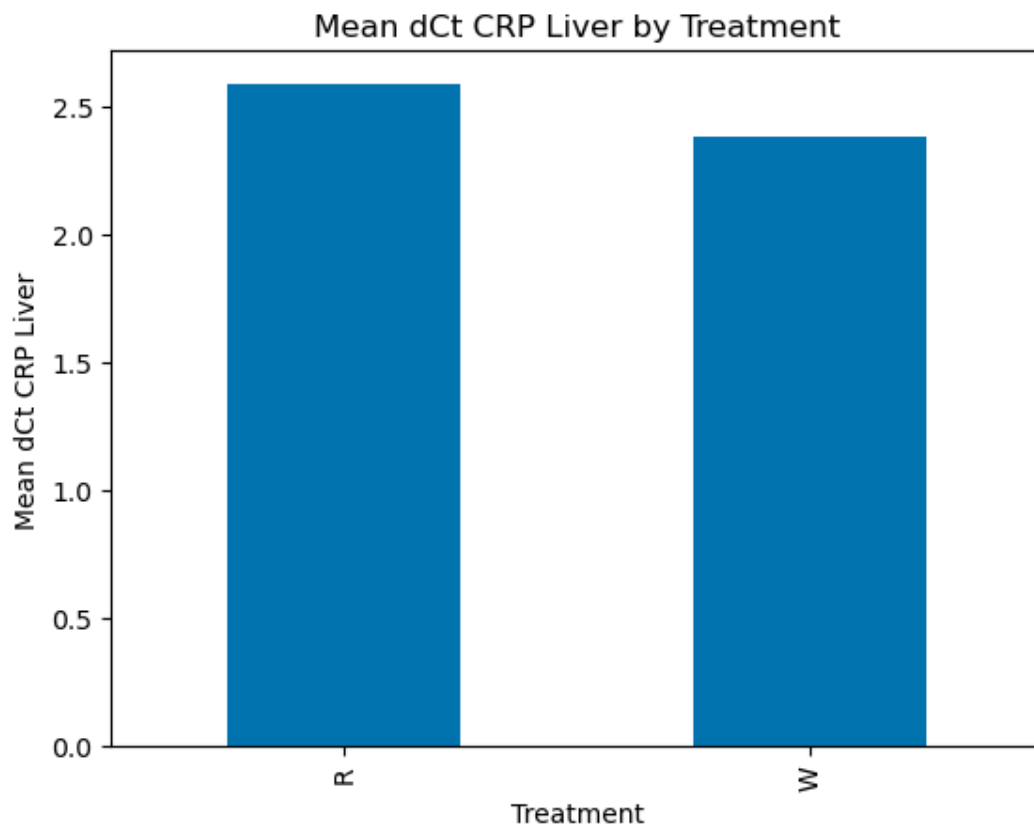
Dataset 2: Alzheimer's Progression

In inferential statistics, with a p-value so high, the null hypothesis is accepted that there is no difference in the Braak Stage 'V-IV' group and Braak Stage '0' group in biomarker data. The Braak Stage 'V-IV' group has markedly similar biomarker measurements than the other Braak Stage groups. This suggests that any level of Alzheimer's is markedly similar to early and later stage progression of biomarkers.

R Group - Pearson Correlation: -0.6267056150840675 , P-value: 0.18301400349578048
W Group - Pearson Correlation: -0.31276776715263405 , P-value: 0.4506831691999088

Dataset 3: Rhodiola

In inferential statistics, with a p-value somewhat high, the null hypothesis is accepted that there is no difference in the inflammatory liver biomarkers from the Rhodiola Treated group and the water treated group. The Rhodiola-treated group has markedly similar biomarker measurements as the water treated group. Statistically water seemed more effective than Rhodiola in showing a smaller amount of liver inflammation



In machine learning, This answer suggests lower inflammatory markers for the mice that got the treatment with Rhodiola Rosea suggesting, that in this logistic regression, this naturopathic herb is efficacious in lowering inflammation in the target groups that received Rhodiola Rosea which is preventative of Alzheimer's pathology. The accuracies fluctuate between 0.66 and 0.33 in different folds which seems like it predicts somewhat ok.

```
Cross-validation accuracy scores: [0.33333333 0.66666667 0.66666667 0.33333333 0.5      ]
Mean cross-validation accuracy: 0.5
Logistic Regression Coefficients: [[-0.05081321]]
Intercept: [-0.28783944]
A lower liver ratio is associated with a higher likelihood of Treatment 'R'
```

Reccomendations

Dangui Shaoyao San is a mixture of several herbs, and is known as a multifaceted herb in Traditional Chinese Medicine. The study above proves that DSS is more efficacious in preventing Alzheimer's pathology than Rhodiola Rosea is. It is reccomended that supplementation with this herbal concoction over Rhodiola Rosea with the guidance of a Traditional Chinese Medicine Practitioner or Naturopathic Doctor, be given serious thought if Alzheimer's is prevalent in one's family.

Supplement companies could market DSS as an anti-neurodegenerative supplement based on the research of the studies above, and even promote a Dangui Shaoyao San supplement as anti-Alzheimer's to whatever legal limits they are able to based on the regulating bodies of their country.

Future Work

In the future, a closer look at *Rhodiola Rosea* can be expanded on. *Rhodiola Rosea* is traditionally used as an Adaptogen and an Adrenal support, and I suppose that reducing stress is good for overall health, but I suppose that this work and its connections may be expanded on in further study.

MLA Works Cited

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